

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
5 August 2004 (05.08.2004)

PCT

(10) International Publication Number  
**WO 2004/066693 A1**

(51) International Patent Classification<sup>7</sup>: **H05K 1/18**,  
G06K 9/00

(21) International Application Number:  
PCT/FI2004/000032

(22) International Filing Date: 22 January 2004 (22.01.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
20030102 22 January 2003 (22.01.2003) FI

(71) Applicant (for all designated States except US): **NOKIA CORPORATION** [FI/FI]; Keilalahdentie, FI-02150 Espoo (FI).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **RYHÄNEN, Tapani** [FI/FI]; Koroistentie 6 B A 3, FI-00280 Helsinki (FI).

(74) Agent: **BERGGREN OY AB**; Jaakonkatu 3 A, P.O. Box 16, FI-00101 Helsinki (FI).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

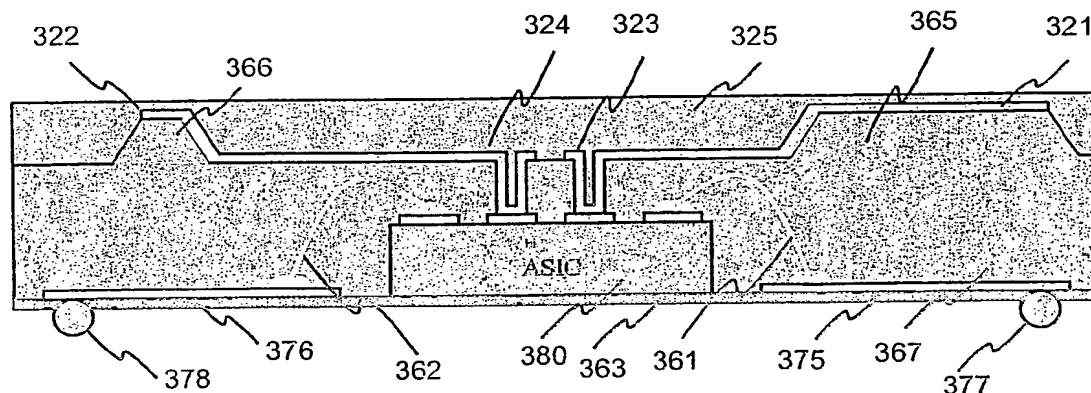
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ARRANGEMENT FOR AUTHENTICATION OF A PERSON



(57) Abstract: The invention relates to an authentication arrangement, which is based on a capacitive fingerprint sensor. The invention also relates to a manufacturing method of such a fingerprint sensor. One essential idea in implementing this invention is to fabricate a capacitive fingerprint sensor on a plastic substrate (363) with an embedded integrated circuit chip (380). The invention also describes a way to create two or three dimensional forms for electrode structures (321, 322, 323, 325, 365, 366) that can be used to optimize the performance of the sensor. When the three dimensional structure is designed to follow the shape of a finger, a very small pressure is required when sliding the finger along the sensor surface. This way the use of the sensor is ergonomic and the measurement is made very reliable. The inventive fabrication method describes the way, how to connect and embed an integrated circuit containing measurements electronics with a batch processed larger scale electrode configuration that is used for capturing the capacitive image of the fingerprint.

WO 2004/066693 A1

## Arrangement for Authentication of a Person

The invention relates to an arrangement for authentication of a person, for example for authentication of a user of a mobile terminal. In particular the invention relates to a fingerprint sensor arrangement. The invention also relates to a manufacturing  
5 method of the inventive fingerprint sensor.

There is a need of providing sensors in mobile terminals in order to make the mobile terminal capable of sensing its ambient conditions. The information can be used for context awareness applications where the ambient information is used for  
10 controlling the user interface profile and different settings of the mobile terminal user interface. Fingerprint sensors are also needed for authenticating the user of the terminal.

There exist several kinds of fingerprint sensors: skin impedance based sensor, thermal sensors, and optical sensors. The most practical solution for authentication  
15 of a user of small appliances, such as mobile terminals, is based on capacitive impedance measurement. The basic idea of the capacitive fingerprint sensor to measure the change of skin impedance is described in Figures 1A and 1B. An array of sensors 120 measure the skin impedance values when a finger 101 is gradually  
20 pulled over the array of sensors. The capacitance between the electrode surface and the conductive saline layer inside the skin surface varies as a function of distance to the conductive layer. The varying air gap and the dead horny cells in the surface of the skin form the capacitance 125 to the conductive layers 121, 122 forming the  
25 electrodes of the capacitive sensor.

Figure 2 shows a rough equivalent circuit of the skin impedance and the impedance measurement principle. Skin has a fixed resistive tissue component 202, and a fixed resistive surface component 203. The measurement capacitance also has a fixed  
30 component 272 and a component 271 that varies according to the surface form of the finger. The capacitive fingerprint sensor measures the varying capacitive component by applying an alternating voltage 281 to a drive electrode 222 and measuring a signal from a sensor electrode 221. The signal is amplified with a low noise amplifier 282, and the phase difference between driver and sensing electrodes is measured, 283. Interference can be suppressed with a guard electrode, which is  
35 kept in the same potential as the signal input using a buffer 285.

A fingerprint sensor also requires a signal processing circuit, which is preferably a silicon-based integrated circuit. One solution for providing a fingerprint sensor would be to use an integrated circuit, which would serve both as capacitive measurement electrodes and as signal processing electronics. This integrated circuit would then be mounted on the surface of the appliance. However, the area needed for the capturing the capacitive image of the fingerprint is roughly in the scale of one square centimeter. This is a very large area for using a silicon integrated circuit as measurement electrodes. Furthermore, the measurement consists of hundreds of capacitive pixels that are arranged in a row or in a matrix depending on the measurement principle. A lot of wiring is needed and the measurement electrodes need to be isolated from the integrated circuits. Therefore a cost efficient method for connecting the capacitive electrodes to the signal processing silicon integrated circuit is needed.

One typical prior art solution is described in patent documents US 5887343 and US 6067368. The problem is solved by using a separate insulating planar substrate to form the measurement electrode. This substrate contains the interconnecting wiring and the vias through the substrate. The substrate is connected to the silicon integrated circuit containing the signal and data processing capabilities. However, this solution is complicated to manufacture because a large number of interconnecting wiring must be connected within a small space. Such wiring also is not very robust, which tends to make the structure to break easily in mobile use.

Another prior art solution is to create the measurement electrodes directly on top of the silicon wafer. This leads to a simple configuration of interconnecting wiring but the solution requires a large silicon surface due to the large area needed for the electrodes.

The prior art solutions also have a disadvantage that relates to security. It is possible to make external connections to the wiring between the capacitive measurement electrodes and the integrated circuit, and by using such a connection it is possible to "record" signals that relate to a certain finger when the finger is measured. It is then later possible to input these recorded signals to the integrated circuit and thus positive authentication result can be achieved electrically without any finger.

A further disadvantage with the prior art solutions relates to the ergonomics of the sensor. A finger must be pressed rather heavily against the flat sensor in order to achieve sufficient contact area between the sensor and the finger. Therefore the

measurement may often fail when the finger is not pressed and slid properly along the sensor surface.

5 The purpose of the invention is to provide a capacitive fingerprint sensor with improvements related to the aforementioned disadvantages. The invented arrangement for fingerprint measurement facilitates good suitability to serial production, good security properties and ergonomics. Hence, the invention presents a substantial improvement to the cost efficiency and reliability of the fingerprint sensors, especially in mobile applications.

10

A fingerprint sensor arrangement according to the present invention, comprising at least one driver electrode and at least one sensor electrode for a capacitive measurement, and an integrated signal processing circuit for the measurement of signals from the electrodes, and interconnecting wiring between the electrodes and the integrated circuit, is characterized in that the at least one driver electrode, the at least one sensor electrode, said signal integrated circuit and said interconnecting wiring are embedded within an integrated module.

15

20 The invention also concerns a mobile terminal, which comprises a fingerprint sensor arrangement according to the invention.

A method according to the present invention for producing a fingerprint sensor, is characterized in that the method comprises the following steps:

- providing a signal processing integrated circuit,
- 25 - providing at least one driver electrode,
- providing at least one sensor electrode,
- encapsulating said integrated circuit, said at least one driver electrode and said at least one sensing electrode into an integrated module.

30 One essential idea in implementing this invention is to fabricate a capacitive fingerprint sensor into a plastic substrate with an embedded integrated circuit chip. The inventive fabrication method describes the way, how to connect and embed an integrated circuit containing measurement electronics, to a batch processed larger scale electrode configuration that is used for capturing the capacitive image of the finger print. The inventive concept can most advantageously be realized using one or several of the following technical details:

35

- 1) Attachment of the silicon integrated circuit on a carrier substrate with interconnecting wiring;
  - 2) Different methods for connecting the integrated circuit electrically to the carrier substrate:
    - 5       - wire bonding,
    - via connection using electroplated, electroless, or thin film metallization, and
    - direct electrical contact from the integrated circuit to the carrier substrate (laser holes, etc.);
  - 3) Molding of a two or three dimensional plastic structure on top of the carrier and  
10       the IC to form a substrate for the measurement electrode;
  - 4) Deposition of the electrode metallization on top of the three dimensional structure with preferably 5-10  $\mu\text{m}$  resolution, and
  - 5) Encapsulation of the structure in plastic.
- 15       Alternatively, if the integrated circuit has a large surface, it is also possible to use an embodiment in which the electrodes and insulating/protective polymer layers are deposited directly on the integrated circuit.
- It is also possible to integrate other types of sensors to the fingerprint sensor unit.
- 20       For example, in one embodiment of the invention a light emitting diode and a light sensitive detector are placed on the opposite sides of the finger groove in order to measure light absorption through the finger. The wavelength of the light used is such that blood in a live finger causes maximal absorption signal. This way oxidized hemoglobin can be detected from the user's finger. Thus by this method also the
- 25       heartbeat rate can be monitored. This makes the usage of any artificial fingers for identification falsification very difficult. In addition, other sensors such as temperature TS and light LS sensors can be integrated within the finger groove and embedded into the fingerprint sensor module.
- 30       The present invention offers important advantages over the prior art solutions. The fabrication process is very simplified, and the invention can be applied to existing fingerprint measurement concepts and electronics to make the fabrication of the device more cost efficient.

Due to the embedded structure the sensor structure is very secure. It is practically not possible to make any external connections to the wiring between the sensor electrodes and the signal processing circuits. Therefore there is a minimal risk of recording signals from actual finger measurements and using them fraudulently.

5

The invention also describes a way to create two- or three-dimensional electrode surface structures that can be used to optimize the performance of the sensor. When the at least two-dimensionally formed structure is designed to follow the shape of a finger, a very small pressure is required when sliding the finger along the sensor surface. This way the use of the sensor is ergonomic and the measurement is made very reliable.

10

An at least two-dimensionally formed structure of the sensor surface is preferably achieved by integrating the sensor electrodes and the measurement electronics such as ASICs into a three-dimensional module using chip-on-flex technology. The chip-on-flex technology is based e.g. on the use of flexible Kapton film as the substrate for wiring and attachment of sensor and ASIC chips. The integrated circuits and sensors are protected using molded polymer cover on top. When using the flexible circuit board for the creation of 2D or 3D structures the sensors and electronics can be a part of the device case.

20

Preferred embodiments of the invention are described in the dependent claims.

Next the invention will be described in greater detail with reference to exemplary embodiments in accordance with the accompanying drawings, in which

- 25    Figure 1A    illustrates using a capacitive fingerprint sensor,
- Figure 1B    illustrates the operating principle of a prior art capacitive fingerprint sensor,
- Figure 2    illustrates a block diagram describing the measurement of skin impedance using active guarding,
- 30    Figure 3    illustrates a cross section of an exemplary arrangement according to the invention, in which wire bonding is applied between a substrate and an ASIC,

- Figure 4 illustrates a cross section of an exemplary arrangement according to the invention, in which metallization connection is applied between a substrate and an ASIC,
- 5 Figure 5 illustrates a cross section of an exemplary arrangement according to the invention, in which an ASIC and electrodes are located on opposite sides of a substrate,
- Figure 6 illustrates a cross section of an exemplary arrangement according to the invention, in which a flexible substrate is bent to serve as a surface for electrical connections of the unit,
- 10 Figure 7A illustrates a cross section of an exemplary arrangement according to the invention, in which metallizations between the ASIC and the electrodes are located on the substrate,
- Figure 7B illustrates a top view of an exemplary arrangement according to the invention, in which metallizations between the ASIC and the electrodes are located on the substrate and in which guard rings are used,
- 15 Figure 8 illustrates a cross section of an exemplary arrangement according to the invention, in which different metallized layers are used for electrodes and guard rings
- 20 Figure 9 illustrates further cross sections and a top view of an exemplary arrangement according to the invention, in which different metallized layers are used for electrodes and guard rings
- Figure 10 illustrates a cross section of an exemplary arrangement according to the invention, in which a flexible substrate is bent to serve as electrodes and a surface for electrical connections of the unit,
- 25 Figure 11 illustrates cross section of a further exemplary arrangement according to the invention, in which a flexible substrate is applied to serve as a surface for electrical connections of the unit,
- Figure 12 illustrates a cross section of an exemplary arrangement according to the invention, in which electrodes and external connections are provided directly on an ASIC,
- 30

- Figure 13 illustrates a cross section of an exemplary arrangement according to the invention, in which electrodes are provided directly on an ASIC, and wire bonding is used between the ASIC and a substrate,
- 5 Figure 14 illustrates a cross section of an exemplary arrangement according to the invention, in which electrodes are provided directly on an ASIC, and metallized connections are used between the ASIC and a substrate,
- 10 Figure 15 illustrates a cross section of an exemplary arrangement according to the invention, in which electrodes and external connections are provided directly on an ASIC using metallization of grooves in a polymer,
- Figure 16A illustrates cross sections of a production sample after phases 160-164 in an exemplary process to produce a unit according to the invention, wherein small ASIC is used,
- 15 Figure 16B illustrates cross sections of a production sample after phases 165 -169 in an exemplary process to produce a unit according to the invention,
- Figure 17A illustrates cross sections of a production sample after phases 170-174 in an exemplary process to produce a unit according to the invention, wherein a large ASIC is used, and
- 20 Figure 17B illustrates cross sections of a production sample after phases 175 -179 in an exemplary process to produce a unit according to the invention.

Figures 1A, 1B and 2 were explained above in the description of prior art.

- 25 Figure 3 illustrates a cross section of an exemplary arrangement according to the invention. The arrangement comprises a substrate 363, which is e.g. Kapton film. The ASIC processing/measurement circuit 380 is attached on the carrier 363. The unit is connected to a printed circuit board by soldering from its soldering balls 367 and 368. The ASIC circuit is coupled electrically to the soldering balls by wire bonding 361, 362 to metallizations 375, 376 on the substrate. The driver electrode
- 30 321 and the sensing electrodes 322 are connected to the ASIC circuit with wires made by metallizations and vias, 323 and 324. The electrodes are made closer to the surface of the unit by producing polymer bumps 365 and 366 to the microreplicated



polymer layer 367. The thickness of the bumps is e.g. 100 - 200  $\mu\text{m}$ . On top of the unit there is encapsulation 325.

5 Figure 4 illustrates a cross section of another exemplary arrangement according to the invention. The arrangement is similar with the previous embodiment of Figure 3, but the contacts from the ASIC to the soldering balls are made with metal film connection vias 461, 462 to the printed metallizations 475, 476 of the substrate. This arrangement requires a thinned ASIC circuit so that the vias 461, 462 do not need to be very deep.

10

Figure 5 illustrates a cross section of a third exemplary arrangement according to the invention. The arrangement is similar with the previous embodiments, but in this arrangement the ASIC is electrically coupled directly to a flexible substrate or "flex" 563. The electrodes 521, 522 and the ASIC 580 are on opposite sides of the substrate. The electrodes are connected to the ASIC with vias 523, 524, which extend to the surface of the ASIC through holes on the substrate. The unit is preferably connected to other electronics with a connector at the end of the flex 563. The flexible substrate is preferably Kapton film.

15

20 Figure 6 illustrates a cross section of a fourth exemplary arrangement according to the invention. The arrangement is similar with the previous embodiment of Figure 5, but in this arrangement the unit is soldered to other electronics. This is achieved by bending 669 and attaching the flex 663 under the unit, and further connecting soldering balls 679 to the flex 663. The layers 625 and 668 are produced by encapsulation.

25

Figure 7A illustrates a cross section of a fifth exemplary arrangement according to the invention. The arrangement is similar with the previous embodiment of Figure 5, but in this arrangement the metallizations 723, 724 between the ASIC 780 and the electrodes 721, 722 are located on the flex substrate 763 thus avoiding one layer of microreplicated polymer and reducing the depth of the vias. Figure 7B illustrates a top view of the arrangement shown in Figure 7A, without the top capsulation. Figure 7B shows the drive electrode 721, which is located on the polymer layer 765. The driver electrode is connected through the via 723 to the ASIC. The Figure also shows the array of sensing electrodes 722 with guard rings 729. The sensing electrodes and guard rings are wired by metallizations to array of the vias 724.

30

35

Figure 8 illustrates a cross section of a sixth exemplary arrangement according to the invention. The arrangement is similar with the previous embodiment of Figure 7, but in this arrangement there are guard electrodes 827, 828 under the sensing electrode metallizations. The guard electrodes and sensing electrodes are both  
5 connected to the ASIC with vias, 826, 824.

Figure 9 illustrates top and cross section views of exemplary sensing electrodes 922 and guard electrodes 928 on a substrate 963. The guard electrodes 928 are located under the sensing electrodes 922 with an insulating layer 929 between the  
10 electrodes. In this embodiment the guard electrodes have larger surface. A buffer amplifier 985 keeps the guard electrodes in the same potential as the sensor electrodes and thus the sensor electrodes are less loaded by the adjacent materials, or interference.

Figure 10 illustrates a further modification of an arrangement where the connection to other electronics is made by bending a flexible printed wired board (PWB) or film substrate 1063 to under the unit, and attaching soldering balls 1078 to the flex. In this embodiment the other end of the flex is bent above the unit in order to use the other end of the flex as electrodes. The wiring to the electrodes 1022 and to the  
20 soldering balls 1078 is provided using two-sided metallization 1030, 1034 of the flex film and vias 1023, 1024. On the electrode end of the flex one metallized surface 1030 serves as sensing electrode and the second metallized surface 1034 of the flex serves as a guard electrode. This construction enables a two- or three-dimensional form of the electrode-finger interface.

Figure 11 illustrates another embodiment where one end of a flexible printed, wired substrate is used for electrodes 1122, and other part of the flex 1163 for external connection. The connections between the metallized surfaces and the ASIC 1180 can be made similar to the embodiment of Figure 10. This construction also enables  
30 a two- or three-dimensional form of the electrode-finger interface. This arrangement can be directly molded into a cover 1168 of e.g. mobile phone.

Figure 12 illustrates a cross section of a further exemplary arrangement according to the invention. In this case the ASIC circuit 1280 is large in respect of the needed electrode structure, and therefore it is possible to create a two- or three-dimensional form of the electrode structure directly on the ASIC. The sensing electrodes 1222 and the driver electrode 1221 are produced on polymer bumps 1266. The connections to the soldering balls 1277 and 1278 are also made using similar  
35

polymer bumps and metallizations. There is a protecting polymer layer 1225 on the ASIC and electrodes.

5 Figure 13 illustrates a cross section of a still further exemplary arrangement according to the invention. This embodiment is similar to the arrangement of Figure 12, but in this arrangement there is a substrate 1363 and bonding wires 1361, 1362 for creating connections from the ASIC 1280 to the metallized pads of the substrate 1363 and the soldering balls 1377, 1378.

10 Figure 14 illustrates a cross section of a further exemplary arrangement according to the invention. This embodiment is similar to the arrangement of Figure 13, but instead of bonding wires the connections 1461, 1462 between the ASIC 1480 and the substrate 1463 are made using metallization.

15 Figure 15 illustrates a cross section of a further exemplary arrangement according to the invention. This embodiment is similar to the arrangement of Figure 12, but this embodiment includes a polymer layer 1525 with preferably 100-150  $\mu\text{m}$  deep grooves 1565. The soldering balls 1577, 1578 are first attached to holes in the polymer, and metallizations 1521, 1522 that form the electrodes are made on the  
20 grooves in the opposite side of the polymer. The polymer substrate 1525 is then attached on the ASIC, 1580.

Figures 16A and 16B illustrate an exemplary process for manufacturing a unit of Figure 4 according to the invention. The Figures show a cross section of the unit to  
25 be manufactured after the concerned manufacturing phase has been executed. First in phase 160 an ASIC circuit is glued on a flexible substrate that includes wiring. The ASIC is preferably a thinned type component with height of only 50 - 100  $\mu\text{m}$ . The flex sheet substrate may be large for attachment of several components. In step 161 a polymer layer is cast on top of the attached ASIC. In step 162 vias are opened  
30 through the polymer layer until the wiring of the flex substrate and to the ASIC pads. The metallization is then electroplated and patterned in step 163. The polymer layer is injection molded using micro replicated mold, step 164.

Next illustrated in Figure 16B, vias are opened through the polymer layer to the  
35 ASIC pads in step 165. This may also be made by cavity molding during the previous step. In step 166 the electroplated metallization is patterned to form the electrode structure. A protective polymer layer is cast on top of the device in step

167. The solder areas of the substrate are then opened, step 168, and finally the solder bumps are processed and diced in step 169.

5 Figures 17A and 17B illustrate another exemplary process, which is for manufacturing a unit of Figure 12 according to the invention. First in phase 170 two or three dimensionally formed structures are fabricated on top of the ASIC surface with roughly 100-200  $\mu\text{m}$  of height. The thin film metallization is deposited on top of the ASIC and the 3D polymer structures in phase 171. The metallization can be made using e.g. Cr-Au. In step 172 a photoresist is electroplated on top of the  
10 metallization. The photoresist is then patterned, step 173, and the metal layers are etched in step 174.

Next illustrated in Figure 17B the photoresist is removed in step 175. A protective polymer layer is cast in step 176, and contact areas are opened for the flip-chip  
15 process, step 177. The soldering balls are then attached with flip-chip bump process in step 178, and finally the produced unit is attached to a cover, step 179.

The invention has been explained above with reference to the aforementioned embodiments, and several industrial advantages of the invention have been  
20 demonstrated. It is clear that the invention is not only restricted to these embodiments, but comprises all possible embodiments within the spirit and scope of the inventive thought and the following patent claims. For example, the inventive idea of the authentication arrangement is not restricted to be used in mobile terminals, but it can be applied also in many other components and purposes. The  
25 invention is not either restricted to use of the mentioned materials.

## Claims

1. A fingerprint sensor arrangement comprising at least one driver electrode (321) and at least one sensor electrode (322) for a capacitive measurement, and an  
5 integrated signal processing circuit (380) for the measurement of signals from the electrodes, and interconnecting wiring (323, 324) between the electrodes and the integrated circuit, **characterized** in that the at least one driver electrode, the at least one sensor electrode, said signal integrated circuit and said interconnecting wiring are embedded within an integrated module.
- 10 2. An arrangement according to claim 1, **characterized** in that said electrode and said integrated circuit are coupled with a substrate (1063, 1163), the substrate comprising said wiring (1030, 1122) between the electrodes and the integrated circuit.
- 15 3. An arrangement according to claim 1, **characterized** in that the substrate comprises the at least one driver electrode and/or said at least one sensor electrode.
- 20 4. An arrangement according to claim 1, **characterized** in that it comprises a substrate comprising wiring (1063, 1163) for an external connection to the integrated circuit.
- 25 5. An arrangement according to claim 4, **characterized** in that it comprises wire bonding (361, 362) between the integrated circuit (380) and wiring of the substrate (363).
- 30 6. An arrangement according to claim 4, **characterized** in that it comprises metallization (461, 462) between the integrated circuit (480) and wiring of the substrate (463).
7. An arrangement according to claim 2 or 4, **characterized** in that said substrate is flexible film.
- 35 8. An arrangement according to claim 1, **characterized** in that said interconnecting wires are metallizations (323, 324) between polymer layers (365, 325).

9. An arrangement according to claim 1, **characterized** in that said at least one driver electrode (321) and/or said at least one sensor electrode (322) is metallization between polymer layers (325, 365, 366).
- 5 10. An arrangement according to claim 1, **characterized** in that it comprises guard rings (827, 828) in the vicinity of the at least one driver electrode and/or in the vicinity of at least one sensor electrode.
- 10 11. An arrangement according to claim 10, **characterized** in that said guard ring is metallization (928) and the arrangement comprises an insulating polymer layer (929) between the guard ring metallization (928) and the sensor electrode (922).
- 15 12. An arrangement according to claim 1, **characterized** in that said integrated module is encapsulated with injection molded polymer.
13. An arrangement according to claim 1, **characterized** in that the surface of said sensor has a curved form in at least two dimensions.
- 20 14. An arrangement according to claim 13, **characterized** in that said form approximates the form of a finger.
15. An arrangement according to claim 1, **characterized** in that the arrangement comprises a bump (365, 366) for elevating the electrodes (321, 322).
- 25 16. An arrangement according to claim 15, **characterized** in that said bump is a layer of polymer.
17. An arrangement according to claim 1, **characterized** in that said sensor comprises one driver electrode (721) and a row of sensing electrodes (722).
- 30 18. An arrangement according to claim 17, **characterized** in that said measurement circuit is adapted to measure successive signals while the finger moves in a perpendicular direction in relation to said row of sensing electrodes, for providing a two dimensional matrix of capacitive measurement results from the
- 35 finger.

19. An arrangement according to claim 1, **characterized** in that the arrangement further comprises a infrared light source, a infrared light detector and second measurement means for measuring absorption of infrared light from the finger.
- 5 20. An arrangement according to claim 1, **characterized** in that said arrangement further comprises a temperature sensor for measuring the temperature from the finger.
21. An arrangement according to claim 1, **characterized** in that said arrangement  
10 further comprises a humidity sensor for sensing humidity of the finger.
22. A mobile terminal, **characterized** in that it includes a fingerprint sensor arrangement according to any of the preceding claims.
- 15 23. A method for producing a fingerprint sensor, **characterized** in that the method comprises the following steps:
- providing a signal processing integrated circuit (160, 170),
  - providing at least one driver electrode (166, 171-175),
  - providing at least one sensor electrode (166, 17-175),
  - 20 - encapsulating said integrated circuit, said at least one driver electrode and said at least one sensing electrode into an integrated module (160-167, 170-176).
24. A method according to claim 23, **characterized** in that said step of encapsulating comprises a step of encapsulating into polymer (161, 164, 167, 176).
- 25 25. A method according to claim 23, **characterized** in that said step of providing said at least one driver electrode comprises a step of metallization (166, 171).
26. A method according to claim 23, **characterized** in that said step of providing  
30 said at least one sensing electrode comprises a step of metallization (166, 171).
27. A method according to claim 23, **characterized** in that the method comprises the step of providing at least one guard ring in the vicinity of at said least one sensor electrode.
- 35 28. A method according to claim 27, **characterized** in that the step of providing at least one guard ring comprises a step of metallization.

29. A method according to claim 27, **characterized** in that it comprises a step of providing an insulating polymer layer between said at least one guard ring and said at least one sensing electrode.
- 5 30. A method according to claim 23, **characterized** in that it comprises a step of providing a substrate and connecting said integrated circuit on said substrate (160) before said encapsulating.
- 10 31. A method according to claim 30, **characterized** in that the method comprises a step of providing an aperture in said substrate (168) for providing an electrical connection through the substrate (169).
- 15 32. A method according to claim 23, **characterized** in that the method comprises a step of providing an elevating bump between said substrate and the electrodes (164, 170).
33. A method according to claim 32, **characterized** in that said bump is made of a layer of polymer.
- 20 34. A method according to claim 30, **characterized** in that said substrate is flexible and includes wiring.
- 25 35. A method according to claim 34, **characterized** in that an end of said flexible substrate is used for an electrically connecting external circuits to the fingerprint sensor.
- 30 36. A method according to claim 34, **characterized** in that wiring of said flexible substrate is used for providing said at least one sensing electrode and/or for providing said at least one driving electrode.
- 35 37. A method according to claim 23, **characterized** in that said at least one sensing electrode and/or said at least one driving electrode is provided with metallization on the surface of the integrated circuit.
38. A method according to claim 30, **characterized** in that an electrical connection is provided by wire bonding between the integrated circuit and wiring of the substrate.



39. A method according to claim 30, **characterized** in that an electrical connection is provided by metallization between the integrated circuit and wiring of the substrate (163).

5 40. A method according to claim 23, **characterized** in that conductive bumps are connected with a flip chip process to a metallization of a substrate or the integrated circuit for providing external electrical connections to the integrated circuit.

10 41. A method according to claim 23, **characterized** in that a polymer layer is provided by injection molding using micro replicated mold (164).

42. A method according to any of claims 23-41, **characterized** in that the process comprises the steps of providing polymer layers (161, 164, 168, 170, 176) and at least one metallization layer (163, 166, 171) one upon the other.

15

43. A method according to claim 23, **characterized** in that the fingerprint sensor is embedded into an equipment cover.

1/12

FIG. 1A  
PRIOR ART

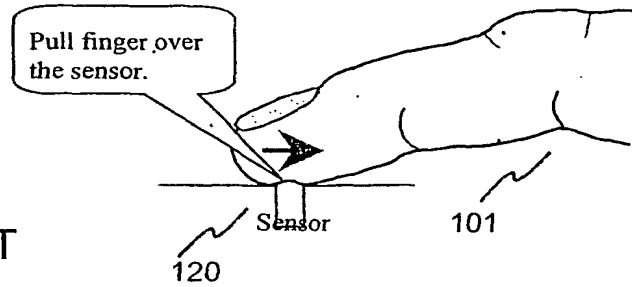


FIG. 1B  
PRIOR ART

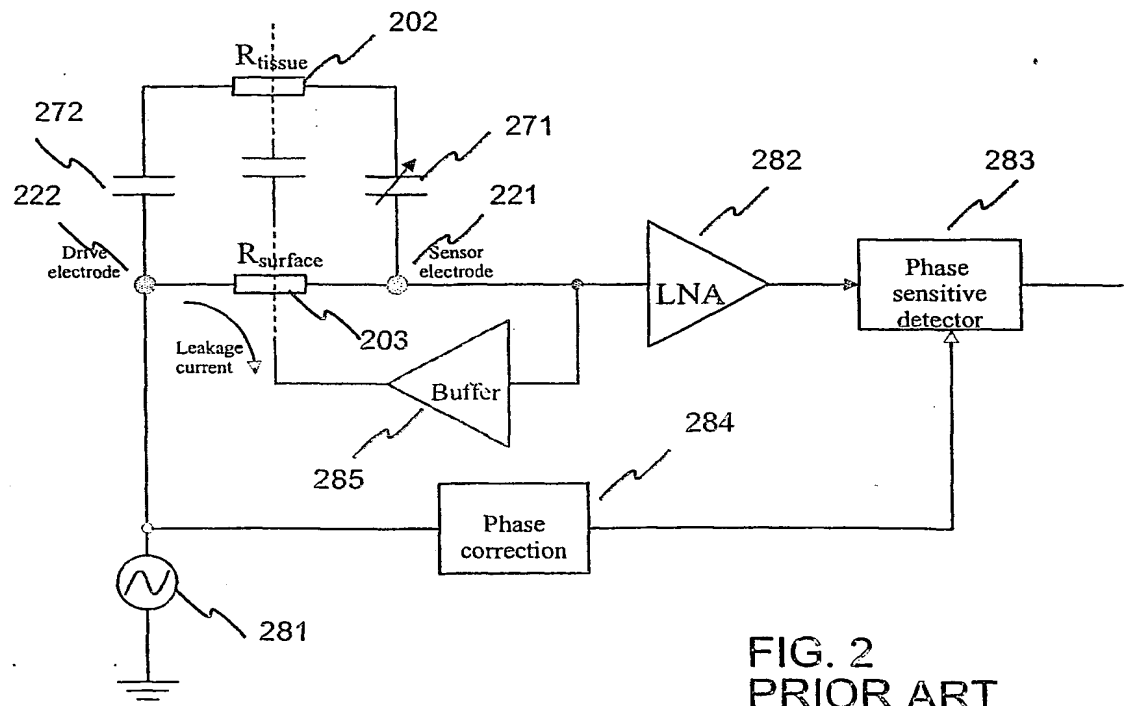
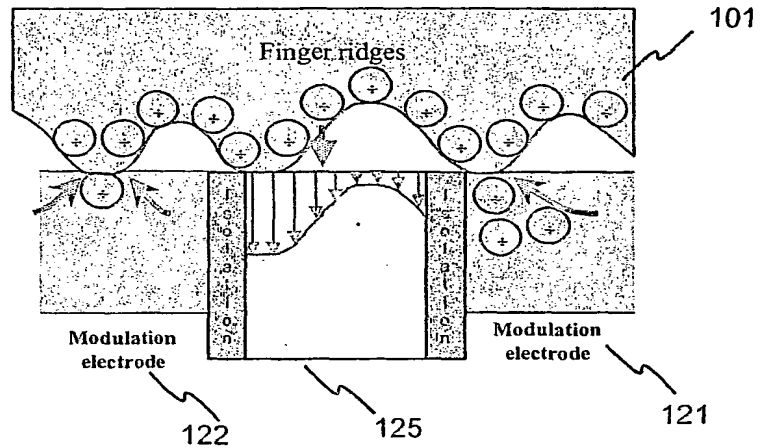


FIG. 2  
PRIOR ART

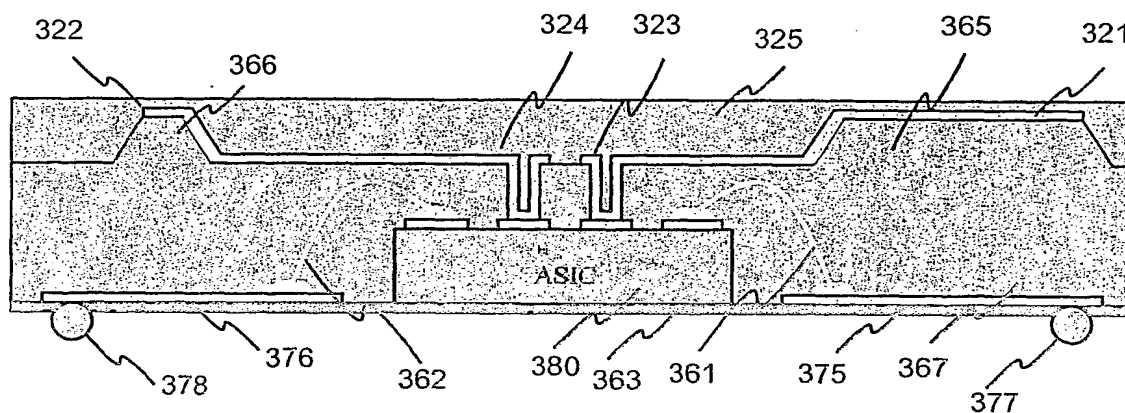


FIG. 3

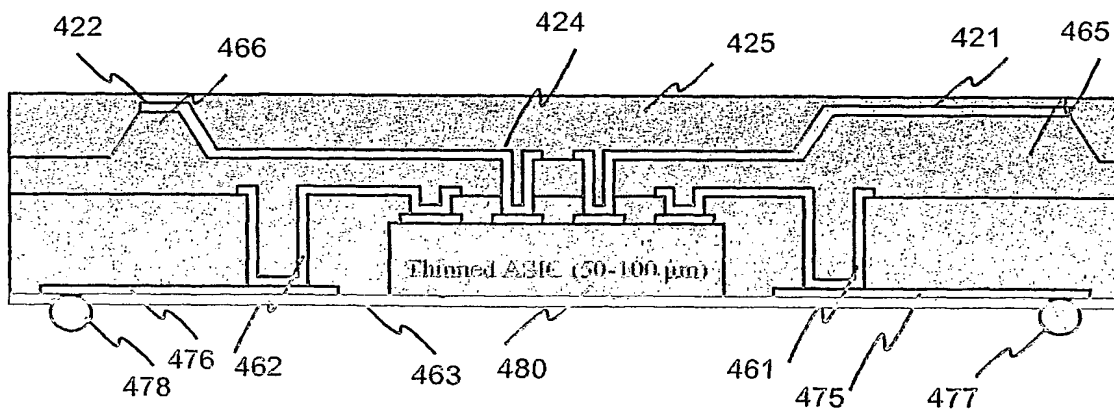


FIG. 4

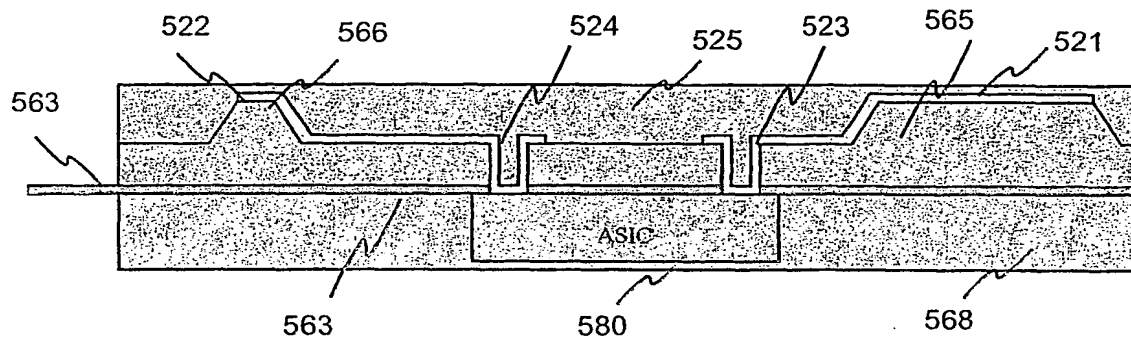


FIG. 5

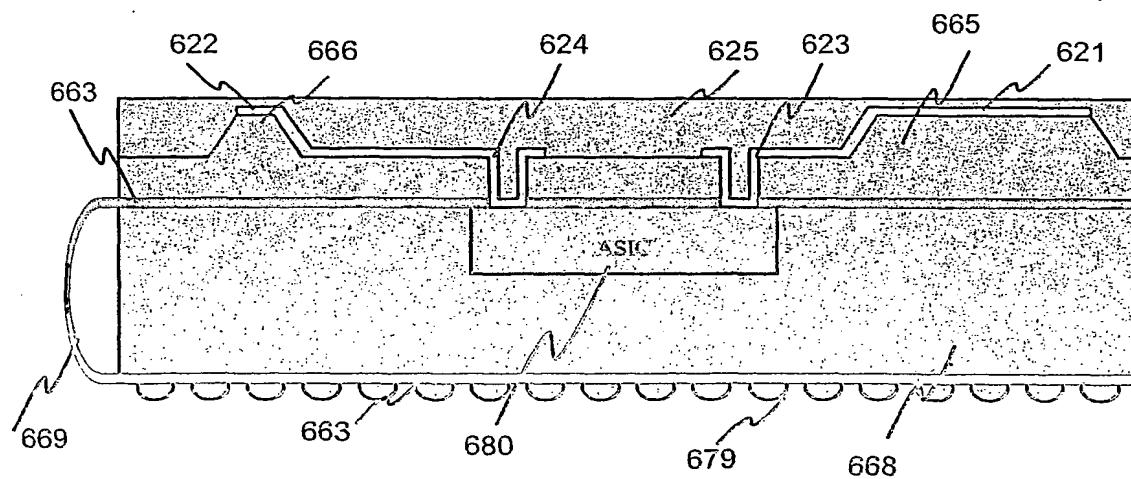


FIG. 6

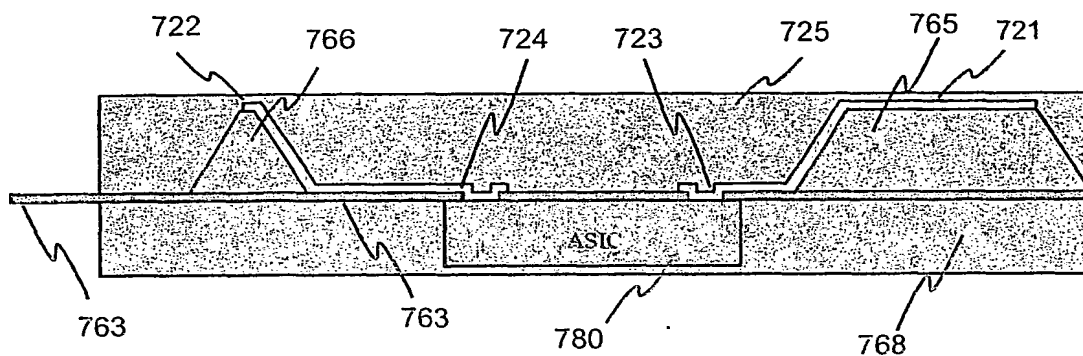


FIG. 7A

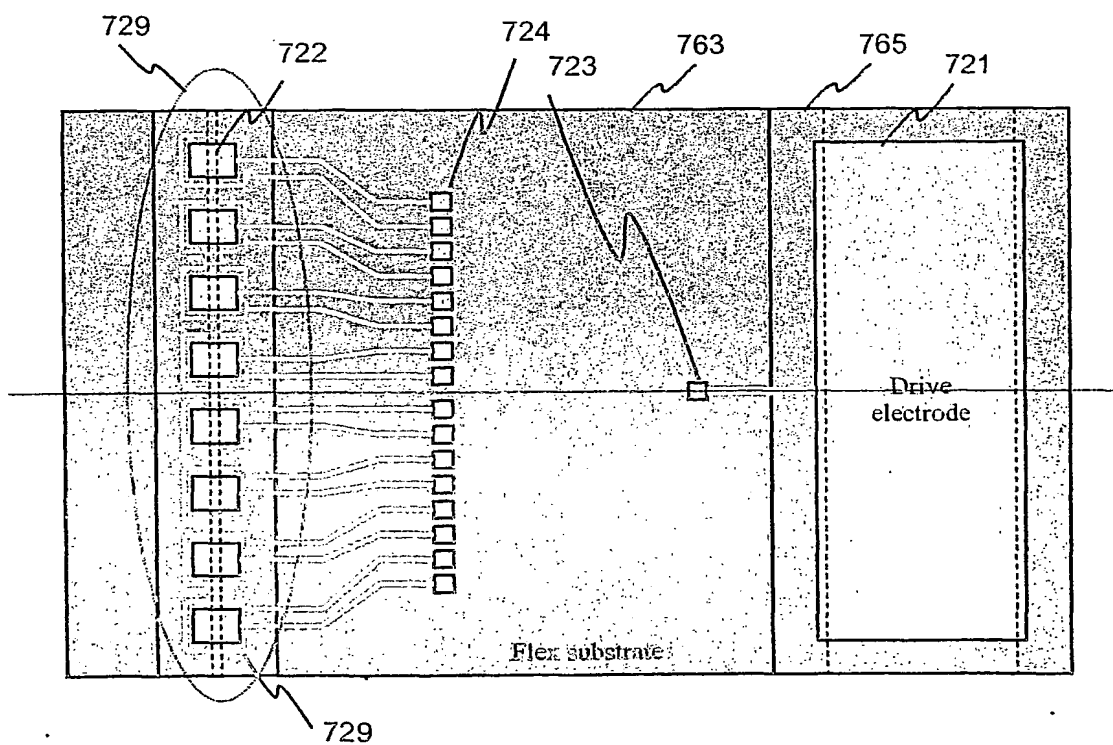


FIG. 7B

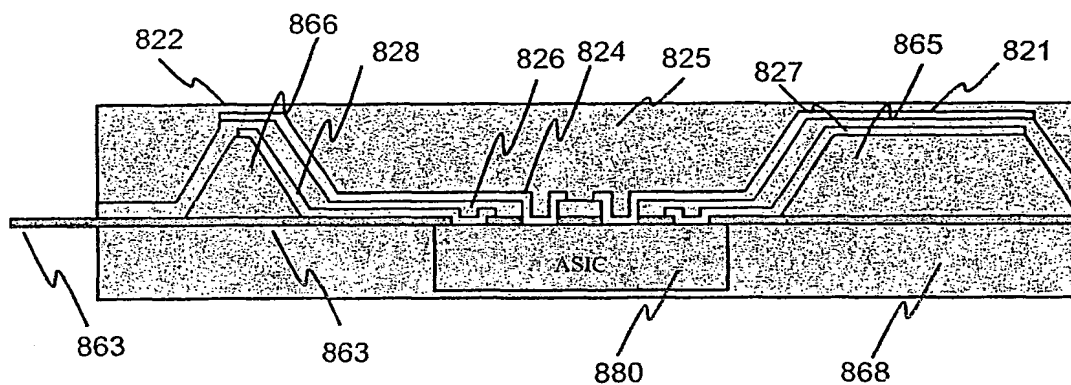


FIG. 8

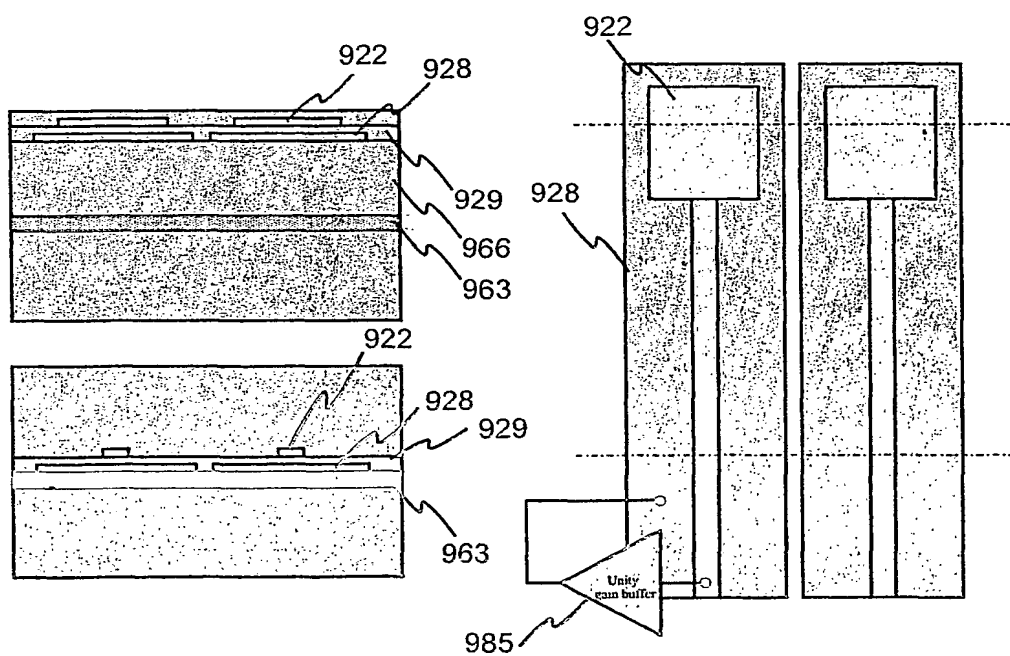


FIG. 9

6 / 12

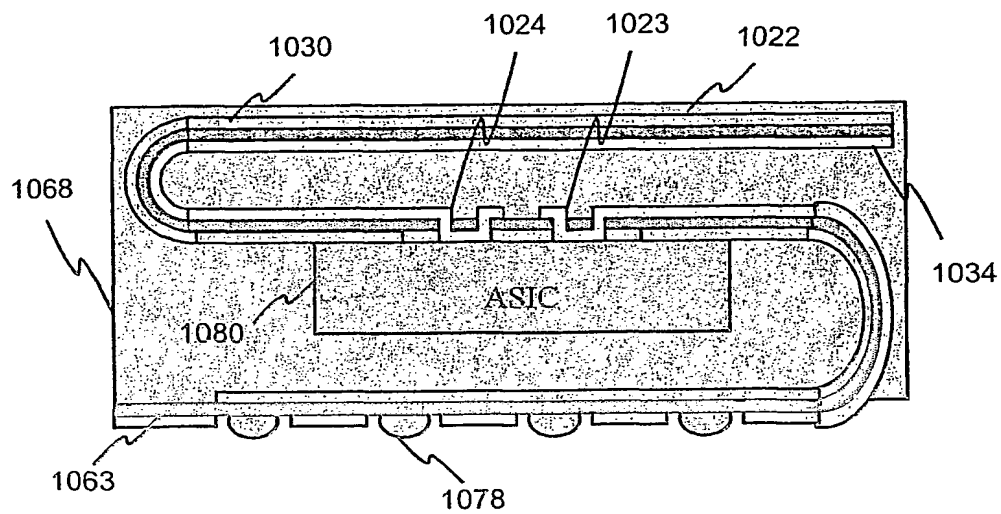


FIG. 10

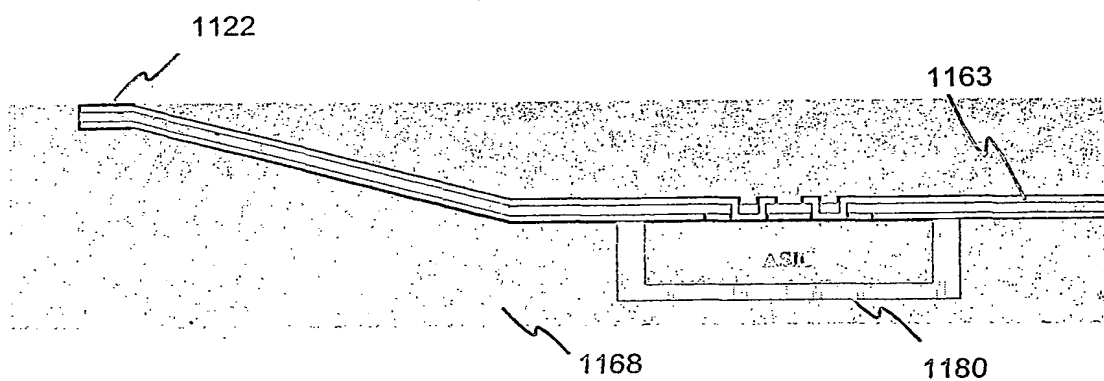


FIG. 11

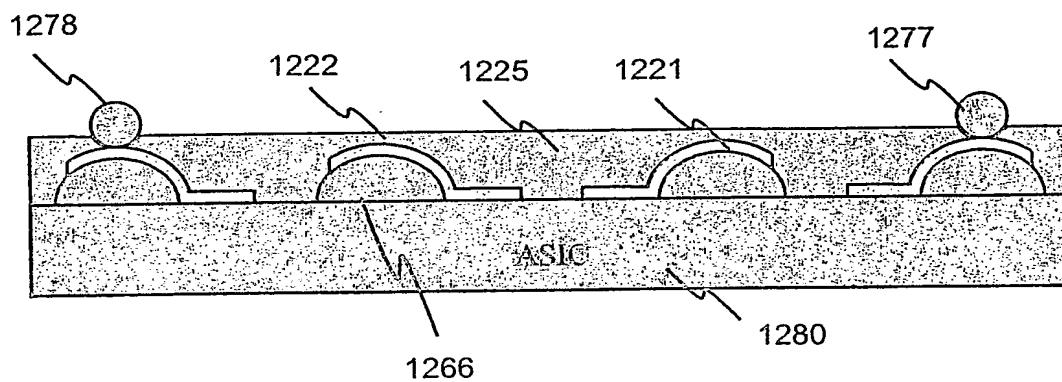


FIG. 12

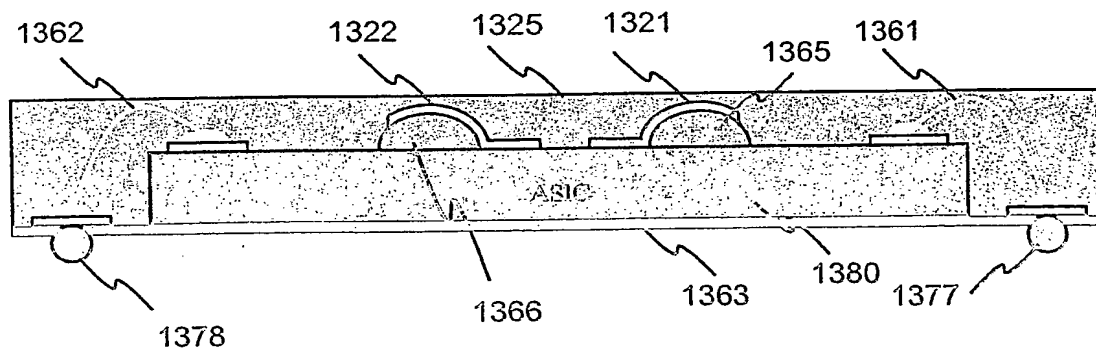


FIG. 13



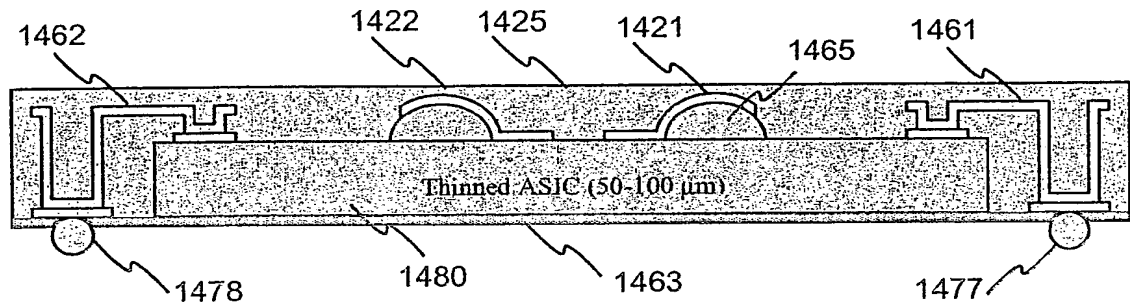


FIG. 14

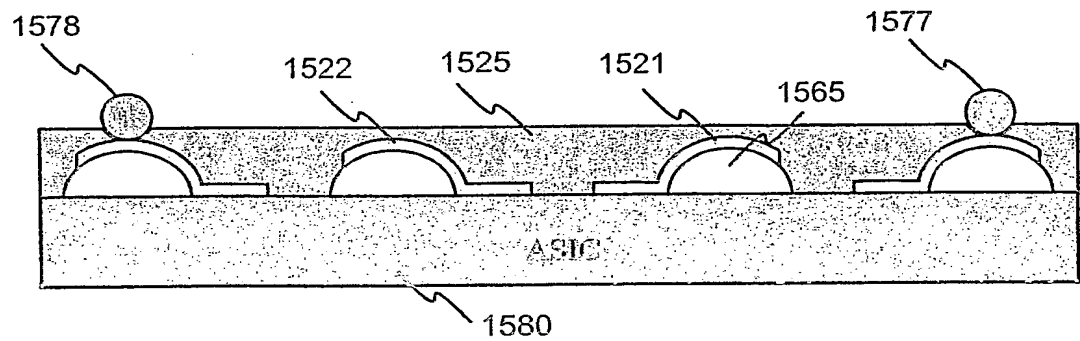


FIG. 15

9 / 12

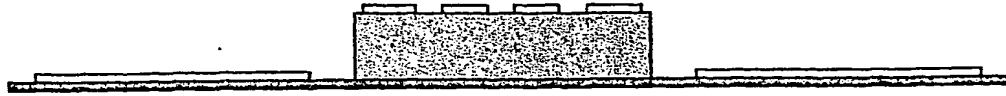
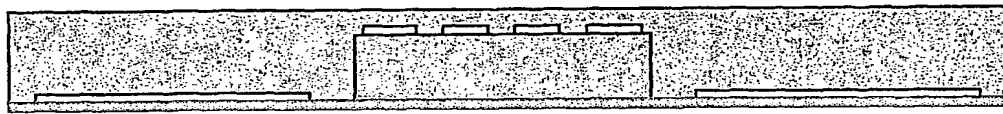
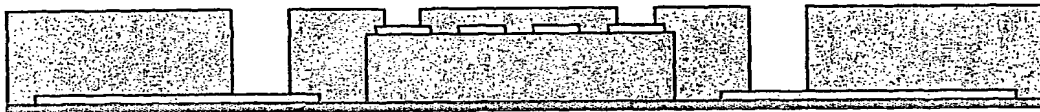
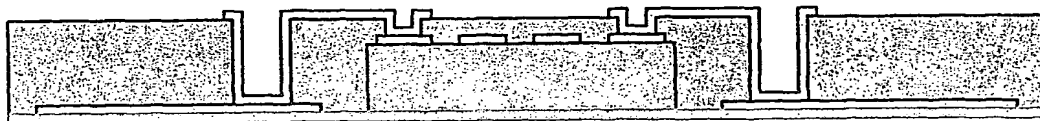
160161162163164

FIG. 16A

10 / 12

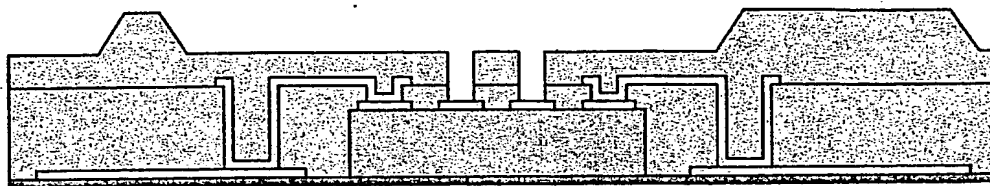
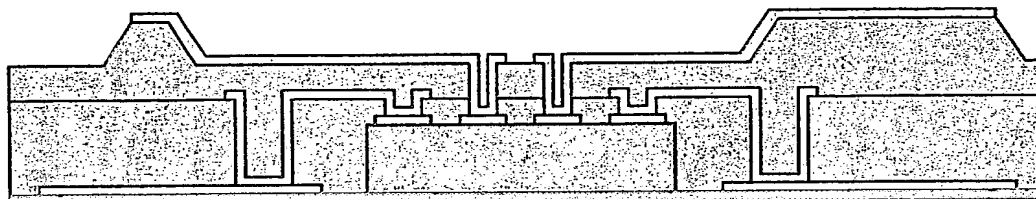
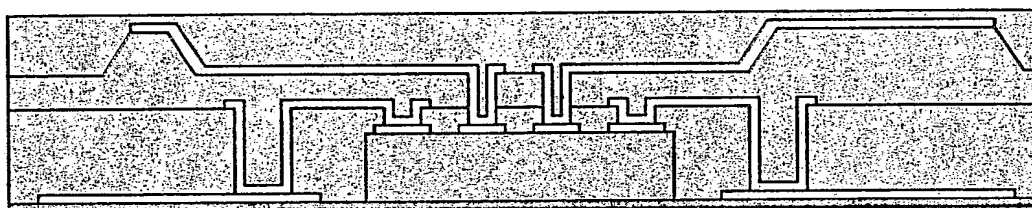
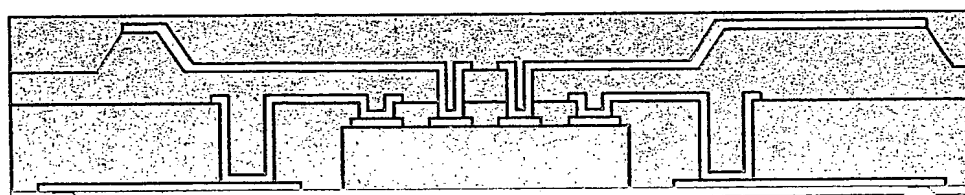
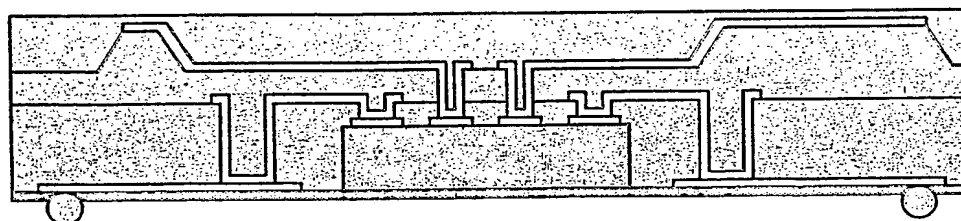
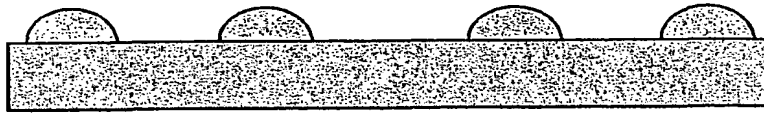
165166167168169

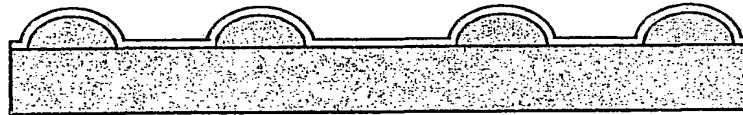
FIG. 16B

11 / 12

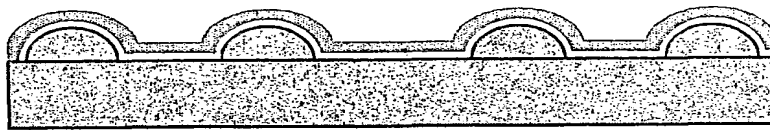
170



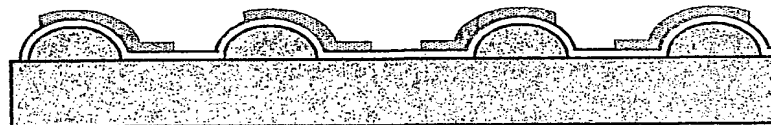
171



172



173



174

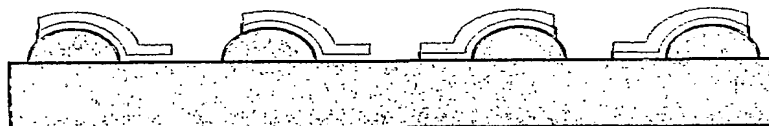
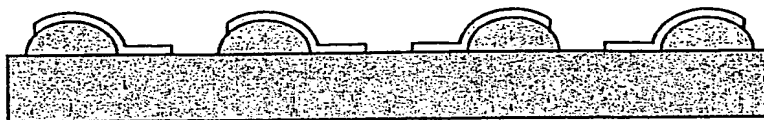


FIG. 17A

12 / 12

175



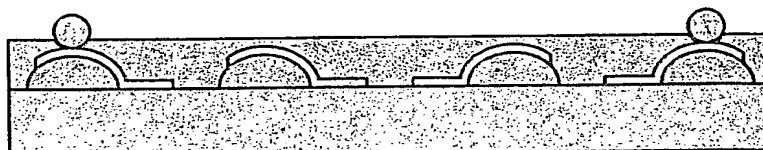
176



177



178



179

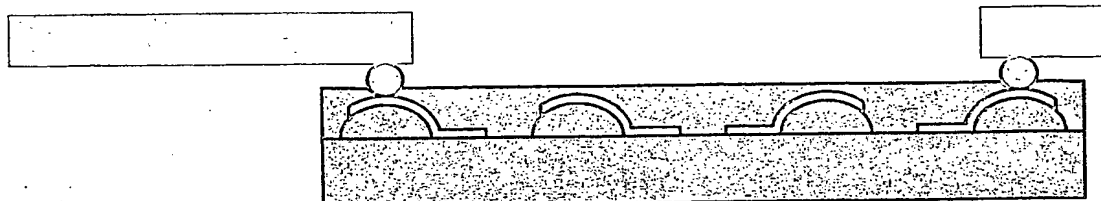


FIG. 17B

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 2004/000032

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H05K 1/18, G06K 9/00

According to International Patent Classification (IPC).or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H05K, G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 0199035 A2 (IDEX AS), 27 December 2001 (27.12.2001), page 1, line 11 - line 15; page 6, line 7 - line 21; page 7, line 10 - line 31, page 9, line 23-30; figure 1; abstract --	1-43
X	US 5862248 A (MATTHEW M. SALATINO ET AL), 19 January 1999 (19.01.1999), column 7, line 2 - line 37, figure 7, abstract --	1-43
A	WO 0106448 A1 (VERIDICOM, INC.), 25 January 2001 (25.01.2001), abstract --	1-43



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 April 2004

Date of mailing of the international search report

29-04-2004

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Daniel Moe/MN

Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (January 2004)

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 2004/000032

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6055324 A (ICHIRO FUJIEDA), 25 April 2000 (25.04.2000), abstract  -----	1-43

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

## INTERNATIONAL SEARCH REPORT

Information on patent family members

27/02/2004

International application No.

PCT/FI 2004/000032

WO	0199035	A2	27/12/2001	AU	6442901	A	02/01/2002
				EP	1303828	A	23/04/2003
				JP	2003536085	T	02/12/2003
				NO	315017	B	23/06/2003
				NO	20003004	A	10/12/2001
				US	2003161512	A	28/08/2003
-----							
US	5862248	A	19/01/1999	AT	216519	T	15/05/2002
				DE	69711964	D,T	28/11/2002
				EP	0789334	A,B	13/08/1997
				JP	9289268	A	04/11/1997
				EP	0786745	A	30/07/1997
				JP	9231346	A	05/09/1997
				US	5956415	A	21/09/1999
-----							
WO	0106448	A1	25/01/2001	AU	6099100	A	05/02/2001
				US	2003107097	A	12/06/2003
-----							
US	6055324	A	25/04/2000	JP	2959532	B	06/10/1999
				JP	11019070	A	26/01/1999
-----							



CORRECTED VERSION

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
5 August 2004 (05.08.2004)

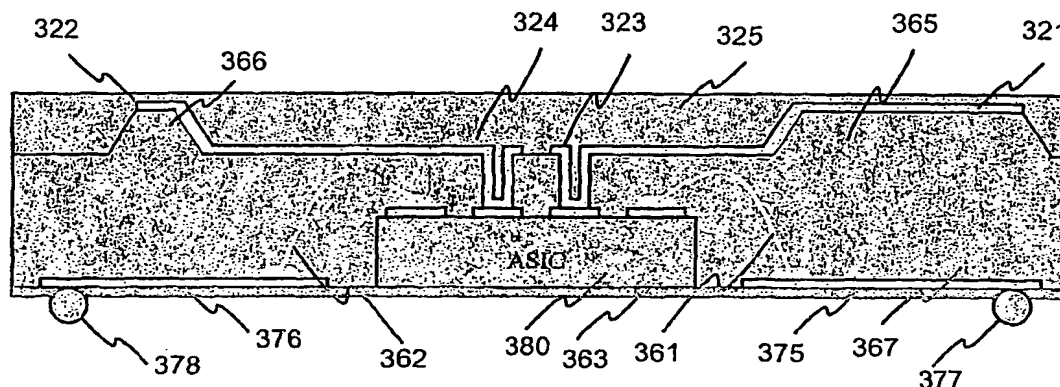
PCT

(10) International Publication Number  
**WO 2004/066693 A1**

- (51) International Patent Classification<sup>7</sup>: **H05K 1/18**, G06K 9/00
- (21) International Application Number: PCT/FI2004/000032
- (22) International Filing Date: 22 January 2004 (22.01.2004)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 20030102 22 January 2003 (22.01.2003) FI
- (71) Applicant (for all designated States except US): **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FI-02150 Espoo (FI).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **RYHÄNEN, Tapani** [FI/FI]; Koroistentie 6 B A 3, FI-00280 Helsinki (FI). **HJELT, Kari** [FI/FI]; Kavallinmäki 17, FIN-02750 Espoo (FI).
- (74) Agent: **BERGGREN OY AB**; Jaakonkatu 3 A, P.O. Box 16, FI-00101 Helsinki (FI).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ARRANGEMENT FOR AUTHENTICATION OF A PERSON



(57) Abstract: The invention relates to an authentication arrangement, which is based on a capacitive fingerprint sensor. The invention also relates to a manufacturing method of such a fingerprint sensor. One essential idea in implementing this invention is to fabricate a capacitive fingerprint sensor on a plastic substrate (363) with an embedded integrated circuit chip (380). The invention also describes a way to create two or three dimensional forms for electrode structures (321, 322, 325, 365, 366) that can be used to optimize the performance of the sensor. When the three dimensional structure is designed to follow the shape of a finger, a very small pressure is required when sliding the finger along the sensor surface. This way the use of the sensor is ergonomic and the measurement is made very reliable. The inventive fabrication method describes the way, how to connect and embed an integrated circuit containing measurements electronics with a batch processed larger scale electrode configuration that is used for capturing the capacitive image of the fingerprint.

WO 2004/066693 A1



**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**(48) Date of publication of this corrected version:**

3 November 2005

**(15) Information about Correction:**

see PCT Gazette No. 44/2005 of 3 November 2005, Section II